A NEW THEORY ON ETHER AND MASS-ENERGY RELATIONS
By Nikola J. Trbojevich (Nicholas J. Terbo) (1886-1973), September 24, 1959

To: Dr. James Corum and Dr. Jasmina Vujic: 30 October 2000

From: William H. Terbo

Enclosed is a copy of my father's space-time physics theory that he developed over forty years ago. I had set it aside several months ago to send to Jim, he being one of the few people I know who has both the knowledge of the field and the (hoped for) willingness to review and comment on what is to me is a fairly esoteric subject. When I mentioned the work to Jasmina during my October 14-17 visit to UC Berkeley to speak to her Tesla history course, she asked for a copy for review. It was the spark I needed to get this effort moving.

I've reread the work today. The words are easy, but the concepts aren't so easy for me so far removed from my physics education. (It put me in mind of reading Stephen Hawking's "A Brief History Of Time." It took me almost two transcontinental air trips to momentarily absorb his less than 200 pages of similar material.) A lot of credit must go to my college friend and tournament bridge partner, the late Burt Randolph, who spent many weeks with my father acting as a "devil's advocate" to force dad to defend his theory, and then managing the organization of the work into its present readable form. (Burt got his doctorate in Mechanical Engineering at Purdue while I was getting my bachelor's.)

This theory is a pretty substantial departure for my father. Most of his previous work was in the invention of various gears, most notably the basic patent on the Hypoid gear in 1923. It was the first gear design using the application of advanced mathematics. (Tesla called my dad "my nephew, the mathematician.") This theory was pretty aggressive considering the year, 1959, and my father's age, 73. Research was complicated as the publishing of much new nuclear science technology was restricted for security reasons, so more credit is due for dad's creativity. I know he spent at least seven or eight years developing his knowledge in the field.

I would appreciate a couple of very brief comments done at your leisure. I really have only two questions that need resolution for my satisfaction. First, was my dad really on to something important, or was it too much of a leap? Second, is the theory good but outdated, or overtaken by current science?

You may distribute this material to your academic colleagues if you wish.

Thanks,

Bill WHT/njtkl

A NEW THEORY ON ETHER AND MASS-ENERGY RELATIONS

(Time and space are discontinuous and consist
of indivisible quanta)

FOREWORD

This paper deals with the structure of the universe, the nature of space and time and the mass-energy relations.

The subject matter is of the kind which is not readily approachable either by laboratory experiments or mathematics. It is the product of free invention.

Nevertheless, the paper contains several ideas relating to nuclear and thermo-nuclear energies, the theories of quanta and relativity, which may have important practical consequences.

The writer spent a lifetime as a free-lance engineer and inventor. It is another object of this paper to demonstrate that the art of invention, when pursued purposively, diligently and professionally, may easily become a most valuable tool in scientific research.

I wish to express my particular thanks to Dr. B. W. Randolph who has read the first two drafts of this paper and has offered a number of valuable suggestions in this connection.

Nikola J. Trbojevich

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Santa Monica, Calif.

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1. Discontinuity everywhere

It is well known that matter, energy, electric charges and actions are all discontinuous and appear as quanta, i.e., in small and indivisible units or bundles.

It is the object of this paper to show that the quantum principle extends throughout the world and embraces space, time, inertia, gravitation and everything else.

The great German philosopher Kant wrote 200 years ago: "A body consists of particles, a motion consists of motions, space consists of spaces and time consists of moments. All physical processes are staccato." This uncanny prediction is held here to be true, as it will be presently shown.

The so-called space will hereinafter be referred to by the term "ether."

2. There Must be an Ether

Ever since Newton, through Maxwell, Hertz, Lorentz and Einstein, there was a profound belief among scientists that action at a distance among material particles was utterly impossible and what is sometimes called the "empty space", must possess some sort of metric or structure which enables the particles to cooperate by means of fields.

Einstein called ether "a four-dimensional space-time continuum", but occasionally he would use the word ether, as in this quotation: "Space without ether is unthinkable for in such a space there would be no propagation of light".

The difficulty in defining of what ether is, or should be, is found in the fact that ether must do so many different things at the same time. It is non-material and yet it interacts with matter. It possesses no inertia and is not subject to gravitation and yet, it is inextricably linked with those two phenomena, and so on.

Michelson-Morley experiments have definitely shown that there was no ether drag. Light, which was supposed at that time to be an entirely ethereal phenomenon showed a most baffling discrepancy in that its velocity was constant whether it was measured in the direction of earth's motion or against it. This led to the well known theory of relativity about which Dr. Soddy once wrote to the effect "Einstein's principle of mass and energy equivalence is a profound truth and a fundamental law of nature which, however, was derived by faulty logic."

In this discussion we shall attempt to revise and amend radically the theories of light and relativity.

D'Abro said once that in Einstein the old-fashioned ether was "reinstated in the guise of a metrical field of the space-time". He further thought that Einstein's geodesic lines must be "a rarified form of matter or a reality of a category different from matter".

Newton believed in absolute space and time, but he did not believe that what he called the "brute masses" could possibly act one upon the other without an intervening medium. Heitler thought that the discontinuous happenings and jumps in atoms "might be caused by some outside influence".

Born said: "Ether must be something very different from ordinary terrestrial substances".

De Bothezat conjectured: "maybe ether is just an even mesh of threadlike subelectrons".

Weyl said: "The centrifugal and other inertial forces take their origin from the metrical structure of the world".

Dantzig said: "Gravitation is not affected by the velocities of bodies". We now conclude: Ether must contain large amounts of energy and/or matter of a sub-gravitational and sub-inertial character which vibrates on the principle of standing waves such as are found in cavity or black body radiation.

The above statement implies that both inertia and gravitation are quantized, i.e., are not infinitely divisible. Both possess a lower limit, just like electric charges or quanta of action, below which they cannot go. This is the novel aspect of this theory and it will be further discussed in this paper.

3. The Structure of Ether

The structures of matter and ether must be complementary of each other. Both must consist of two congruous networks of equispaced discontinuities. It is only in this manner conceivable how it is possible for bodies to move through ether without a drag.

From this it follows that time and space must also be discontinuous and must consist of quanta.

These statements when proved, may become factors of considerable importance not only in physics but also in engineering. Once we can establish a one-to-one correspondence between the structures of ether and matter, we may determine the structure of ether from the structure of matter or conversely. Obviously this "double-check" should be useful in many applications, as for instance in comprehending the structures of various nuclei. The principle should also make it possible to verify this theory by laboratory experiments.

It is interesting to note that the structure of ether may be determined by calculation only. It is possible to do so, once the principle of complementarity between space and matter has been accepted.

Another interesting application of the principle of complementarity is that it explains the universal "tremor", as Dirac called it, which pervades all the matter in the universe.

As is well known, all particles of matter move, rotate or vibrate forever without any consumption of energy and without any visible cause.

This is due to the vibration of ether. According to this theory ether is a field of standing and monochromatic waves uniformly extending throughout the universe.

The matter particles act as impurities imbedded in the pristine cleanliness of ether and are floating around in its meshes in very much the same manner as the colored pollen grains move about in water in the Brownian effect.

Ether particularly resembles the cavity radiation in Kirchhoff's black body furnace in all respects except that the radiation field is of an incomparably higher frequency and is strictly monochromatic.

Dirac's "tremor" was noticed by many other physicists.

Gamow called it "the restless universe".

De Broglie said once: "the question may be asked whether our customary ideas of time and space which we believe to be a perfectly continuous framework, were genuinely valid".

Zeno thought that time was discontinuous just like matter and was composed of "moments". Born referred to it as the "inexplicable stability of atoms".

Jeans said "either causality or continuity must be renounced". He further said: "Bohr jumps prove that there is no continuity in space and time". F. A. Lindemann stated that "if we postulate that the space and time are not continuous, the whole quantum theory follows naturally as a consequence". Soddy said: "zero point energy proves that the state of rest in nature is unthinkable." Heisenberg and other scientists at one time seriously considered the discontinuity of space and time. The units or quanta of space and time were named "hodon" and "chronon", respectively.

We shall now proceed with the calculation of the space and time quanta.

4. Calculation of the Space and Time Quanta

It was stated in previous paragraphs that the principle of complementarity will enable us to determine the structure of ether by calculation only.

According to this theory, the meshes of ether must correspond to the meshes of matter exactly.

From this it follows that nature cannot build a particle larger in diameter than a single mesh or cubicle of space. This defines the diameter of the space quantum d.

Mosharaffa once suggested that matter may be nothing but "congealed radiation". In the light of this theory, Mosharaffa's statement is true. This gives us an interesting view on the possible origin of the universe. As the Bible says: "fiat lux", ether was the first and matter the second, to appear on the scene of creation.

Thus, the universe may be conceived as being a large mass of vibrating photon gas, which is energy, in which a very small part consists of impurities, which is matter, resulting from the partial condensation of that gas. According to an estimate made by Einstein and others, the solid matter in the vast ocean of ether, i.e., the photon gas, amounts to only about one part in 10^{30}.

It will be noted that while this theory is completely strange to all our perceptions yet, mathematically it is ridiculously simple.

This will come as a welcome relief to many of us who cannot find sufficient time to enthuse about tensors, Christoffel and the Italian calculus.

It is now possible greatly to simplify such abstruse doctrines as quantum mechanics, the theory of relativity, the relativistic mass increase, the dual aspect of light and many other difficult problems.

The explanation is that the theory is self-complete and explains the universe as if the universe were only a very large machine having a limited number of operations, all of which are strange, but not too complicated when compared with the tremendous complexity in toto.

As already stated, the wavelength of ether is equal to d which is also the diameter of the largest solid particle which nature can build.

It is assumed that the said largest particles are the neutron and proton, or, more correctly, the solid cores of the said nucleons.

A neutron or a proton then consists of a solid core which is assumedly spinning and is therefore surrounded by a photonic fuzz, probably a modification of the de Broglie wave. The mass of this fuzz is very small and may be considered as negligible in this calculation.

Hence the mass of the said solid core of a nucleon is taken to be very nearly equal to the atomic mass unit:

$$m = 1.66 \times 10^{-24} \text{ gram}$$

The velocity of light $c = 3 \times 10^{10}$ cm/sec

The Planck constant $h = 6.6 \times 10^{27}$ ergsec

Let N denote the frequency of ether, then $\frac{1}{N}$ will be the time quantum.

$$\text{velocity of light} = \frac{\text{space quantum}}{\text{time quantum}} = Nd \qquad 1)$$

Note than both quanta may be obtained entirely by calculation, i.e., without any recourse to experiments or laboratory measurement.

All that is required is to know the three great constants of nature namely, the velocity of light c, the quantum of action h, and the atomic mass unit m.

The above three constants comprise among them the entire structure of the universe.

The calculation may now proceed along three different formulas, respectively belonging to Planck - Einstein, de Broglie and Bertrand Russel.

All three of these formulas express the same thing, that is, the equivalence of mass and energy and they can be deduced one from another.

Einstein - Planck: $mc^2 = h N$ 2)

De Broglie: $d = \frac{h}{mc}$ 3)

Russel: Energy x time of one vibration = action 4)

Regarding the above Russel formula, it may be pointed out that Russel was the first, we believe, who pointed out that in the theory of quanta it is the action and not the energy of radiation which is of prime importance. Said Lord Russel: "Perhaps a theory giving more prominence to action may be possible and may facilitate a simpler statement of the quantum principle". In this theory, we found the above suggestion very productive as it fits into this scheme perfectly.

The maximum momentum which nature can produce in a single particle is the product of the mass of the said heaviest particle and the maximum velocity, the velocity of light.

In Russel's formula, equation (4), the energy may be denoted with $E = mc^2$ and the time of one vibration is the time quantum $\frac{1}{N}$. In de Broglie's equation (3) the minimum wave length is the space quantum $\underline{d}$. Hence, we write:

$$E \times \frac{1}{N} = h \qquad 5)$$

$$\text{from which } N = \frac{mc^2}{h} = \frac{(1.66 \times 10^{-24})(9 \times 10^{20})}{6.6 \times 10^{-27}} = 2.3 \times 10^{23} \text{ per sec}$$

Hence, the maximum frequency (or action) which nature can produce and which is numerically equal to the frequency and also the action of ether is:

$$N = 2.3 \times 10^{23} \text{ per sec} \qquad 6)$$

The time quantum is the reciprocal of frequency:

$$\frac{1}{N} = 4.4 \times 10^{-24} \text{ sec} \qquad 7)$$

The space quantum $\underline{d}$ is equal to:

$$d = \frac{C}{N} = 3 \times 10^{10} \times 4.4 \times 10^{-24} = 1.32 \times 10^{-13} \text{cm} \qquad 8)$$

Noting that the space quantum d is also the diameter of the largest solid particle, the maximum specific gravity or density of the primordial matter is:

$$\text{Max. density } \gamma = 1.38 \times 10^{15} \text{ gram/cm}^3 \qquad 9)$$

The results so far obtained are:

space quantum	$d = 1.32 \times 10^{-13}$ cm
time quantum	$\frac{1}{N} = 4.4 \times 10^{-24}$ sec
max. frequency	$N = 2.3 \times 10^{23}$ per sec
max. density	$\gamma = 1.38 \times 10^{15}$ gram/cm^3

5. The Theory of Unit Photons

The theory of unit photons is probably the most speculative and controversial part of this paper. However, this concept explains so many things which could not be explained before that we believe the idea is fundamentally correct.

Einstein wrote once: "Matter is where the concentration of energy is great and field is where the concentration is small".

We already mentioned Mosharaffa who suggested that "matter is nothing but congealed radiation". A Soviet scientist, J. Frenkel, voiced a similar opinion when he wrote: "Matter is a collection of interpenetrating dynamical fields, electromagnetic and nuclear, with material particles and bodies forming nodal points".

How can we explain the true nature of a field? It is to be noted that ether, as herein defined, is also a field. Fields are not subject to gravity, they possess no inertia and yet, they are capable of interacting with matter. How can that be? The answer is:

There are entities in nature which contain sub-gravitational and sub-inertial matter. Fields are such entities.

When Einstein analyzed the photoelectric effect, he conceived the idea and the word "photon".

We usually speak of energy of the light quanta. However, it was Russel, previously quoted, who first pointed out that in radiation it is the action and not the energy which is of prime significance. Action is a product of energy and time in which time represents the duration of a single impulse. Obviously then, the shorter the pulse, the higher the quality of action during a given time interval. In this sense, action replaces the concept of temperature in radiation and leads to the application of the thermodynamical law of entropy in radiation.

In the preceding paragraphs, we postulated the geometrical structure of ether. It appears that both space and time are atomicized. Space is divided into a network of small cubes, or possibly spheres, each having the edge, or the diameter, equal

to 1.32×10^{-13} cm, while time is divided into moments, each moment lasting 4.4×10^{-24} sec. In the deduction stated, only three well known constants of nature were used. The most important of the three seems to be Planck's unit of action $\underline{h} = 6.6 \times 10^{-27}$ ergsec.

It is, of course, to be understood that the quantized space-time concept applies only to the inside of the universe which is considered finite. What lies beyond, it is impossible for us to know or even imagine.

The fact remains that the concepts of space and time are meaningless and wholly mathematical, unless something is happening in them. Thus, we must ask ourselves the question: Why should these two entities be quantized and how?

The only consistent answer is: The space must be full of energy. As Max Born once remarked: "A vibration is impossible unless there is something to vibrate with". That "something" consists of unit photons. Inasmuch as energy and matter are equivalent and convertible one into the other, it follows that space must also contain matter.

Just because matter and energy embodied in ether as defined here are not detectable by any of our instruments or senses and that they are not subject either to gravitation or inertia, it is no proof that they do not exist. It is readily imaginable that our bodies and instruments are completely transparent with respect to ether. The presence of ether is noticeable only in a round-about way, e.g., by means of centrifugal forces and the resistance of bodies to various types of acceleration and changes of momentum.

It is also equally imaginable that certain smallest particles, the unit photons, are able to escape the meshes of gravitation and inertia, providing however that they are suitably dispersed over the required number of space quanta.

We shall now calculate the mass of the unit photon and denote it with the symbol μ.

The largest energy quantum which nature can produce was already calculated:

$$E_{max} = mc^2 = hN = 1.5 \times 10^{-3} \text{ erg} \quad (10)$$

in which m is the mass of the solid core of the nucleon and N is the frequency of vibration of ether.

We assume that there also exists a minimum quantum of energy in universe.

After Planck's definition, it may be assumed that the quantum of action h is indivisible and that no smaller quantum than h can be found in nature. Since h contains no fractions, nature can only form a series of following energy quanta:

$$h/sec,\ 2h/sec,\ 3h/sec,\ \ldots\ldots\ldots\ hNerg \qquad (11)$$

That is, there are $N = 2.3 \times 10^{23}$ possible energy quanta in nature, ranging from a minimum $E_{min} = h/sec$ to a maximum $E_{max} = hNerg.$ (12)

Similarly, there are 2.3×10^{23} possible action quanta. The action series is of the following form:

$$h,\ 2h,\ 3h,\ \ldots\ldots\ldots\ hN' \text{ ergsec} \qquad (13)$$

Note that in the above action series N' is no longer a frequency, it is only a number.

We are now in a position to define the minimum energy and action quanta or units.

$$\text{Minimum energy} = \mu c^2 = h/sec = 6.6 \times 10^{-27} \text{ erg} \qquad (14)$$

$$\text{Minimum action} = h = 6.6 \times 10^{-27} \text{ ergsec} \qquad (15)$$

From this the mass μ of the unit photon is

$$\mu = \frac{m}{N'} = \frac{1.66 \times 10^{-24}}{2.3 \times 10^{23}} = 7.2 \times 10^{-48} \text{ gram} \qquad (16)$$

Ether contains one unit photon in each space cubicle or quantum.

All matter is composed of unit photons in various degrees of concentration. For example, the solid cores of nucleons comprise 2.3×10^{23} unit photons each while the electrons consist of only 1.23×10^{20} unit photons each and each occupies a single space quantum.

The density of matter $\rho = 1.38 \times 10^{15}$ gram/cm^3, as already stated. Thus, a cm^3 of the primordial matter would weigh upwards of a billion tons!

Further calculations show the following dimensions of the unit photon:

mass = 7.2×10^{-48} gram

diameter = 2.7×10^{-25} cm

cross section = 5.7×10^{-26} barns

number/cm^3 = 4.4×10^{38}

energy density of ether = 68 kg cal/cm^3

volume = 5.2×10^{-63} cm^3/unit photon

density of ether = 3.16×10^{-9} gram/cm^3

From the above it follows that both energy and action are atomicized entities and consist of very small and indivisible units or quanta, h/sec and h respectively.

6. Cavity Radiation and Steady States

As it was already mentioned, this theory is based on the principle of standing waves. Such standing fields may be found in Kirchhoff's "heated enclosures" and also in atoms.

The modern quantum physics is based mainly upon the properties of nuclear and electronic shells in atoms. A "steady state" is obtained when the periods of vibration are quantized according to certain quantum numbers. In this way the vibrations and spins are endlessly repeated and the dissipation of energy from the atom is thereby prevented.

From these considerations came the following supposition:

The entire universe is in fact a standing wave field.

In heated enclosures, the cavity is filled with a standing field of radiation only, the air having been previously exhausted. Of greatest interest is to note that as soon as a state of equilibrium is reached between the walls of the vessel and the radiation, no further addition of heat or any other energy is required to maintain the field. Thus, space has a certain capacity for absorbing and holding energy and that capacity increases with the temperature. The wave length is the measure both of the temperature and the specific energy content in a cavity.

In ether, the field acquires its maximum possible rate of vibration, $N = 2.3 \times 10^{23}$ per sec and therefore, the maximum specific action per cm^3. However, this action is not associated either with temperature or pressure.

One might ask here: how and why? The explanation is that in pure ether there are no collisions. Each unit photon vibrates in its own space quantum and does not collide with the next photon in the next space quantum. Heat and pressure will be generated only in the presence of matter which may be considered as a derivative and an impurity somehow created from ether itself in the distant past.

A steady state of a field, or radiation, is characterized by the fact that energy is neither absorbed nor emitted unless there be a perturbation of some

kind. In such a case a field may act as a reflector, a resonator or a transformer with respect to the said extraneous impulses.

All standing fields require a boundary. Ether itself must have a boundary which will reflect the waves coming in one direction and turn them around to travel in the opposite direction.

We can only speculate on what the boundary of ether might be.

It is conceivable that the absolute vacuum which surrounds the universe acts as an insulator or reflector through which the unit photons cannot pass, or if they do pass, can only pass with a finite velocity.

In such a case, the dissipation of ether may not be noticeable within historic times, providing however, that the universe is much larger than we think it is. The present estimate of the radius of universe is approximately 1.2×10^9 light years, but if the universe expands with the speed of light as it seems reasonable to assume, that radius is altogether too small by a factor of about 10.

Einstein had this same difficulty with his space time continuum because that continuum must also have a boundary.

It will be remembered that Planck discovered the quantum of action h in studying the heated enclosure in 1900. This phenomenal discovery forms the basis of modern physics and of this theory as well. Of particular interest is the de Broglie's discovery of waves which accompany any moving particle. The theory is based on Planck's quantum of action and Einstein's discovery of the mass-energy equivalence.

In this theory, de Broglie's principle is extended by reversal. Thus, when a body moves, it is surrounded by a swarm of unit photons, the waves. In reversal, whenever a body is surrounded by a swarm of unit photons, it must move. This leads to the most significant assumption, namely: all forces, momenta, kinetic energies, relativistic increments of masses, etc., are caused by means of transference of unit photons from one body to another. This transference may also be tied in with the law of entropy, meaning that free photons may be

transferred from a locus of a greater action to the locus of a lower action, but not in the opposite direction. By this means the principle of nuclear energy transference also becomes clearer. This factor also justifies us in assuming that ether is an inviolable standing field and possesses a higher frequency and action than any other entity in the universe, including the intranuclear binding energies.

7. The Subgravitational Masses

The idea that there exists matter which is not subject to either gravitation or inertia will be considered by most people as absurd and impossible.

Yet, by far the largest proportion of matter in the universe is of such a character. It was already calculated that ether consists of 4.4×10^{38} space quanta for each cm^3 and each such quantum contains a unit photon having a mass of 7.2×10^{-48} gram. From this, the specific gravity, or density, of ether is equal to 3.16×10^{-9} gram/cm^3. In other words, each km^3 of "empty" space contains three tons of matter, approximately.

The question now arises: just where does the line of demarkation, existing between imponderable and ponderable matter lie?

In ether or in light, there is only one unit photon in a space quantum. As is well known, these entities possess no ponderable mass and no inertia. Inertial effects will be noticeable in these entities only when they are perturbed by matter and thus lose their original structures. For example, light cannot exert pressure until it ceases to be light.

When a number of photons congregate in the same space quantum and the number increases up to a certain not now known amount, the entity will become ponderable, i.e., it will be affected by gravitation and will presumably exhibit inertial properties. But where?

We know already that an electron consists of 1.23×10^{20} unit photons. At this point the electric charges appear. This might be significant. It is conceivable, but not proved as yet, that electric charges, the gravitational effects and inertia all would appear together, at the same point of unit photon density.

This hypothesis ought to be investigated in laboratories. If it should prove to be true, the key to the long sought "unified theory" for which Einstein searched so long, would be found.

Another curious result would also be forthcoming. All ponderable mass increments should be integral multiples of the electron mass, 9.1×10^{-28} gram.

This might be possible to verify experimentally by measuring the relativistic mass increases, for example, in a cyclotron. If this hypothesis should be true, the relativistic mass increases will also be found to consist of finite and indivisible q uanta, each such quantum being exactly equal to the "rest mass" of an electron.

8. The Mechanics of the Universe

The universe as a whole is an operative mechanism or process. Therefore, it must comprise all the operative elements which are sufficient and necessary for its operation. We know some of these elements, but the most important details are still missing. For example, we cannot explain the reasons for the universal "tremor" which pervades the world, the electric charges, the gravitation, inertia, the relativistic mass increase, the dual nature of light, the transference and equipartition of forces, momenta and kinetic energies, the real cause of inertia, the stability of the atoms and so on, ad libitum.

There is no question but that universe somewhat resembles a colossal thermodynamic machine. It operates on the basis of reversible and irreversible cycles and obeys that most fundamental of all laws of nature, the law of entropy.

Entropy means a degradation in the quality of energy and becomes evident wherever an irreversible thermodynamic cycle operates.

Entropy also means a transition from the state of orderliness into disorderliness.

It also means a change from less probable combinations into more probable combinations.

The reversible processes are those in which no energy is gained or lost. Such processes are quasi-perpetual because by means of "steady states" and "standing waves" the motions, vibrations and rotations are frictionless and continue forever without abatement. The best examples for this kind of operation are the ether, the atoms, the heated enclosures and the behavior of gases in general.

From a practical standpoint, the irreversible processes are much more interesting, because it is only by means of irreversible cycles that we are able to obtain energy from nature's reservoir, for our own uses.

It is an object of this article to show that the law of entropy governs not only the thermodynamic cycles but that it also applies to radiation.

In radiation, the temporal sequence of the emission of unit photons is the action.

The numerical magnitude of action is the definition of the quality of energy.

The law of entropy demands that in irreversible processes the magnitude of action must be degraded in each cycle.

All energies, including the nuclear energy, are based on the degradation of the action of unit photons, i.e., whenever the cycles are irreversible.

We may now ask the question: In precisely what manner is the action of unit photons transferred? Just as in heat transfer: the body having a higher temperature causes the heat to flow downwardly, toward lower temperatures but never, as a rule, in the opposite direction.

Similarly in radiation, energy having a higher rate of action will tend to dissipate itself into a number of lesser actions, but never in the opposite direction. The Compton effect, the radiation coming from the sun and stars, the nuclear energy as exemplified by fission, fusion and radioactivity, all follow the rules of entropy increase.

The law of entropy also throws an interesting light upon the history of universe. As was previously stated, entropy increase means also an increase in disorderliness. From this it follows that originally, universe must have been in a greater state of orderliness than it is now. Ether is the uppermost limit of orderliness, in fact, it is the orderliness itself. From this we conclude that ether is the origin of everything else, that is, the world as we know it in all its aspects and combinations, is only a derivative of ether.

9. Remarks on the Theory of Light

According to this theory, ether is a volume of very thin photon gas which vibrates in a steady state and at a constant wave length, throughout the universe.

The wave length is a constant of nature, 1.32×10^{-13} cm, the edge of the space quantum, while the time of one vibration is another constant of nature, the time quantum, 4.4×10^{-24} sec. Each space quantum contains one unit photon having a mass of 7.2×10^{-48} gram and a diameter of 2.7×10^{-25} cm.

Light spreads through ether in very much the same manner as does electric current through a wire. A unit photon arrives into a space quantum and dislocates the photon already there. That photon imparts the impulse to next quantum and photon, that one to the next and the next one with the result that the original impulse spreads all the way through the universe. When the said impulse finally collides e.g. with a mass particle, this will form a perturbation in the process, and the nature of light will correspondingly change. A beam of light is thus composed from a multitude of such elementary rays.

Action is the number of impulses per second, i.e., the sum per second of individual unit pulses each having an action numerically equal to $\underline{h}$ in each ray.

There is no way of finding out just exactly how the space quanta are arranged. Light finds its way through the quanta by following the principles of least action and least time, the said two principles being also known as the Maupertuis and Fermat principles, respectively.

Hence, the straight line propagation of light is not literally true. Light rays are transmitted in only approximately straight lines through ether. There might be some privileged directions along which the line of propagation is somewhat straighter than along others, but it is doubtful that this slight variation could ever be experimentally proved because the aberration at best is very minute.

This theory postulates, therefore, that light is a corpuscular, or more correctly, an action phenomenon caused by the dislocation of unit photons in ether.

It consists of individual unit pulses of the same velocity and magnitude h. The number of the pulses per second determines the action of each light ray and when the said action is multiplied by frequency, we obtain the familiar energy quantum. It is to be noted that the dimension of action is ergsec and that of energy is only erg.

As is well known, the light quanta occupy an enormous range when classified according to their wave lengths. Wave lengths are always expressible in integral numbers of space quanta and the reciprocals of frequencies are expressed in integral numbers of time quanta in this theory. The energy of any single ray is not affected by the distance traveled. From this it follows that the exact location of the source of ray is immaterial. It further follows that any ray passing through our instruments, as in Michelson-Morley experiment, for example, is an entirely local phenomenon. By this means it is possible to explain the "negative" result of said experiment without any recourse to the theory of relativity, as it will be furtherin shown.

10. On the Origin of Electric Charges

The nature and origin of the electric charges is easily the most baffling problem in the entire physics.

It is interesting to note that according to the present theory, the electric charges do not appear until the density of unit photons reaches 1.23×10^{20} per space quantum, i.e., the mass of the electron.

The theory further postulates that the above photon density is some kind of a critical number in nature, at which also the gravitation and the inertia make their first appearance. This should be checked and possibly verified by thoughtfully planned experiments. The proof would consist in checking the relativistic mass increments of electrons in a cyclotron. The increments should all be integral multiples of electron masses, i.e., quantized.

It seems that electric charge results from a spin. Furthermore, the spin must be three dimensional as for instance happens in a helix or a spherical helix, because, only in such a case would it be possible to distinguish between right-hand and left-hand directions. Ordinary circle or ellipse would not do because e.g., a clockwise rotating circle becomes anti-clockwise when turned upside down. But a right-handed helix always remains right-handed regardless of how it is being turned around.

By this means it would be possible to distinguish between positive and negative charges.

It remains to imagine some sort of process by means of which the charges of equal sign repel each other and those of the opposite sign attract each other. Induction and the pair formation from gamma rays are also terrific problems.

Ether is a positive field of equal potential throughout the space. Attraction and repulsion require fields of a variable potential. In particular, attraction is the result of a negative field while repulsion implies a positive field.

Fields may be superposed and added like vectors.

Hence, all fields are combinations of at least two fields, one of them being ether.

Gravitation is relatively easily explained because the field being attractive, is negative and has the characteristics of a shadow, i.e., the potential diminishes towards the body.

In electric charges, the situation is confusing because the positive and negative charges seem to be fully equivalent and yet they are different from each other.

Dirac's idea on positron is interesting but it is hardly understandable or imaginable. The idea of a negative energy levels and holes in what might be termed a plasma is attractive enough, but it is difficult to see the mechanism inside the atom which can produce such holes.

11. On Nuclear Energy

This theory throws an interesting light upon the possible geometrical structure of nuclei. In fact, the diameters of various nuclei may now be determined by calculation and more accurately than ever before.

This is due to the pecularity of the disposition of matter with respect to the space quanta.

As was previously stated, by the virtue of the rule of complementarity existing between space and matter, no particle can occupy more than one space quantum at the same instant. Similarly, no two nucleons can touch one another, and the minimum distance between the two adjacent nucleons must be equal to at least one space quantum, or to an integral multiple thereof.

Yukawa, in calculating the exchange forces, predicted the existence of mesons. He assumed that the center distance between two adjacent nucleons was 2.6×10^{-13} cm. This is in close agreement with this theory, in which the exact Yukawa distance should be 2.64×10^{-13} cm.

Another example may be mentioned in this connection. The radius of an alpha particle was estimated in laboratory measurements to be equal to 2×10^{-13} cm. The correct diameter is 3 space quanta and the radius is 1-1/2 space quanta, that is, 1.95×10^{-13} cm. Note the close agreement between laboratory measurements and the theory.

The reason why two nucleons cannot touch each other is that on account of the fields, the spins and the interposed de Broglie waves, such a contact is physically impossible. Furthermore, that fact has also been experimentally proved, witness the above two examples.

Nuclei contain "bottled-up" energy in the form of binding energies. As is well known, the nuclei consist of a plurality of major particles, protons and neutrons and of intranuclear spaces filled with matter or radiation of lesser density than the said nucleons.

As no nucleon can occupy more than one space quantum at any one time and no two nucleons can touch each other except through fields, as already stated, it follows that each nucleon must be surrounded by from six to twelve empty space cubicles, depending on the geometrical and crystalline arrangement of the said quanta. From this it follows that the nucleus is to a large extent empty. This writer once calculated the matter content of a uranium nucleus and found that the nucleus was approximately 92 per cent empty, based on a hexagonal crystalline structure presumed in the nucleus.

Matter obviously exists in two modifications, as it might be termed, the "hard" matter and the "soft" matter.

"Hard" matter is found in the solid cores of neutrons and protons. The "soft" matter consists of mesons, electrons, positrons and neutrinos.

As first suggested by Mosharaffa, it may be imagined that matter originated from "congealed radiation". Thus "hard" matter may be conceived to have first appeared in the form of droplets resulting from the condensation of ether.

Before such a condensation could take place, it was necessary for ether to be first organized into a complex consisting of definite and stable space and time quanta.

The said "droplets" became the cores of the neutrons and protons, the "hard" matter. The remaining "soft" matter was formed, according to this hypothesis, from the grouping of free unit photons about the said cores as a result of the spin and the perturbation of the structure of ether. By this means neutrons, protons and possibly antiprotons might have been formed.

Hence, we may explain why the said droplets or cores seem to be all exactly alike throughout the universe. The space quanta are simply a measure or the capacity of ether to form droplets of solid matter of a predermined diameter and density.

It is, therefore, reasonable to assume that the cores consist of matter 100% pure and inert. This explains why e.g., in fission or fusion only the "soft" parts of matter can be utilized for the production of energy while the cores remain unalterable and intact.

This form of reasoning leads to another interesting hypothesis about the cause of the stability of atoms. In this writer's opinion, the cause will be found in the principle of entropy. This hypothesis will be now discussed.

12. A Hypothesis on the Stability of Atoms

As it was already stated, all electromagnetic radiation is in substance of the same character. Each ray consists of a series of impulses and each impulse consists of a dislocation of a single unit photon. The only difference is in time intervals, as measured in time quanta, which separates one impulse from the next one.

Hence, the difference is in the action of the individual rays. Rays transmitted through ether follow the principles of least action and least time. Therefore, the successive pulses follow the same paths through ether. The paths of rays are very nearly straight lines but not necessarily exactly so.

Ether comprises one unit photon in each and every space quantum in a three-dimensional array. All these photons vibrate in their respective space quanta because of the steady state and a standing wave properties of ether.

From this it follows that ether represents the ultimate or maximum of action because the time interval between two successive pulses is the shortest possible and is exactly equal to one time quantum, 4.4×10^{-24} sec. All other electromagnetic rays exhibit greater time intervals, i.e., the successive pulses are separated from each other by a plurality of time quanta.

Action is closely analogous to temperature and temperature is a thermodynamical concept contained in the law of entropy. Namely, a transition from a state of lesser entropy, i.e., lesser time intervals between adjacent pulses to those of a greater entropy number is permissible, but the process is irreversible as previously stated.

Due to certain perturbations to which ether is subjected by the presence of matter, it is possible for a plurality of unit photons to occupy the same space quantum. In this way fields and matter may be created.

However, it is to be noted that each unit photon acts in its own behalf and has its own particular action. Therefore, while the energy content of a certain space quantum may be enormously increased by the infusion of a great number of unit photons, that does not mean that the action was increased to a point above that of

ether. By definition, that is impossible, because ether already possesses the maximum of action and all other combinations or groupings of unit photons must, of necessity, possess a lesser action.

Thus, the intraatomic or intranuclear photon congregations possess more energy per space quantum, but less action than ether.

This brings into play the law of entropy. A transition of photons from ether into the atom is impossible after a certain level of saturation has been accomplished in atoms and a steady state has been obtained. We have here a situation in which two steady state configurations are imbedded one into the other. That is, atoms including nuclei, are fields of a lesser action imbedded into a field of a greater action. That such a thing is possible, can best be seen from the behavior of particles in cavity radiation. There, foreign particles, provided that they have smaller diameters than the wave length in the cavity, will vibrate together with the remainder of the radiation in the cavity indefinitely.

Hence, the origin of nuclear energy and the Aston mass defect may be explained. As Einstein already quoted said, "Matter is where the concentration of energy is great, and field is where the concentration is small". Nuclei, therefore, consist of matter and fields, all of which have a greater specific energy content and less action, than ether. Note that energy consists of unit photons and the quality of energy consists of the actions of the said photons. On the other hand, electric, inertial and gravitational effects are unobservable until a certain, predetermined density of unit photons per space quantum has been obtained.

It was already suggested that there might exist in nature a critical number, or a critical density of unit photons, 1.23×10^{20} per space quantum, at which point matter appears as such i.e., it becomes ponderable and capable of exerting electrical and inertial properties. We shall need another Millikan or a J. J. Thomson to prove this hypothesis experimentally. It was suggested in a preceding paragraph that relativistic mass increases might be quantized in accordance with the said critical number.

This would explain the true nature of the binding energies, i.e., the "soft" part of matter in nuclei. Thus in Aston curve, only such portions of unit photons which exceed the critical density would appear as parts of the nuclear mass. The rest, if any, would not be noticed or detectable by our instruments.

In producing nuclear energy, it appears that after the processes of fission or fusion have taken place, the nuclear bonds are broken to a certain extent and the captive unit photons are dispersed in the adjoining space, thus reducing both the action and density of the captive photons. The loss of action appears as a gain of energy, and the loss of density appears as a loss of ponderable matter. These two altered conditions seem to fulfill exactly Einstein's famous mass energy relation $E = mc^2$.

The available intranuclear action is dissipated in the form of Compton effects following the rule of increased entropy.

Thus, the only possibility of obtaining usable energy from any source is to generate irreversible processes in which the action and density of unit photons per quantum are reduced and entropy is correspondingly increased.

13. The Basis for a Unified Theory

It was a long sought object in science to find some sort of a mechanical or factual basis for a doctrine which would bring the electrodynamic, inertial or gravitational effects observable in nature, under the same unified heading.

Einstein was particularly diligent in search of such a principle.

Unfortunately, the mathematical and laboratory methods have proved insufficient to even approach this "problem of problems."

It was often said in the past that "God must have been a mathematician". Granting that this statement is true, it is by no means certain that God was using the same kind of mathematics which we are using.

The difficulty is in the fact that our mathematical and laboratory resources are full of holes. As this article proves to a certain extent, some of the most important factors in nature are totally inaccessible either to mathematical or laboratory treatment.

In the writer's opinion, the only possibility of coming anywhere near the solution of this intricate problem is by means of philosophy and invention.

Einstein himself was of this opinion when he said: "The bases of science which cannot be obtained by experience, can be attained only by free invention". In fact, in looking over the recent history of science, we come to the conclusion that most of the prominent physicists in the twentieth century were actually inventors in disguise. It is practically impossible to discover anything really new in physics or mathematics any more without first generating in one's mind an inventive or creative idea or, as Henry Poincare pointed out, "a number of closely related ideas, all aiming at the same objective". These ideas are usually of a subconscious origin.

In this theory it is believed a good beginning was made along these lines by first postulating that there must be an ether, i.e., a complex having a maximum of action and a minimum of unit photon content.

If we now assume a further hypothesis, namely, that in nature there is such a thing as a critical number, that is, a critical density of unit photons occupying the

same space quantum at which point the electrical charges, the inertia, and the ponderability of matter make their simultaneous appearance, the unifying principle will loom on the horizon, as already stated.

It was also previously suggested in this paper that the existence of the said critical number might be provable experimentally.

14. Remarks on the Theory of Relativity

An important byproduct of this theory is that it leads to a very considerable simplification of the theory of relativity.

As is well known, the said theory originated from the Lorentz-Fitzgerald equations and the Michelson-Morley experiments. Upon these bases, Einstein and Minkowski constructed an elaborate mathematical structure of a four-dimensional space-time continuum.

Strictly speaking, there is no direct connection whatever between space and time. Both are imaginary and mathematical concepts, something like two coordinates in geometry.

In this theory, the space and time quanta have been determined on the basis of certain constants peculiar to this universe of ours. It is easily imaginable that in some other universe, or, for that matter, in this universe when and if such constants of nature as the Planck constant, the atomic mass unit, the velocity of light and the density or specific gravity of the primordial mass were altered, the relations between space and time quanta would also be altered. Hence, there is no organic or immutable connection between space and time.

It is sufficient to recall the method according to which the space and time quanta were calculated in this theory:

$$\text{velocity of light} = \frac{\text{space quantum}}{\text{time quantum}} = c$$

$$\text{wave length of ether} = \frac{h}{mc} = d$$

in which the wave length is equal to the diameter of the largest solid particle which the nature can build and m is the mass of the said particle. The said diameter can also be determined by knowing the mass m and its density γ, or by measuring the velocity of light.

However, it may be regarding the space-time continuum, the theory of relativity led to three basic discoveries in physics namely, a) the rule of the mass-energy equivalence, $E = mc^2$, b) to the mass increment of bodies at velocities approaching

that of light and c) in establishing the velocity of light as the maximum possible velocity which the nature can produce and its constancy in all directions.

As it happens, since Einstein's discoveries a great many things happened to science and now we find that all three theses of Einstein may be proved to be correct without even saying a word anywhere about relativity and its marvellous mathematics.

This goes to show that in the theory of relativity, the most important discoveries were made not by mathematics, but, we are tempted to say, in spite of it. They were discovered by invention and the mathematical dressing-up only served the purpose of making the inventions acceptable and palatable to certain mathematically inclined circles. This fact was well known e.g. to Soddy, already quoted. We now briefly analyze the three discoveries, a, b, and c.

a) Mass energy equivalence is amply proved by fission, fusion, pair formation, radioactivity and the Aston curve. No relativity needs to be mentioned here at all.

b) The mass increment (relativistic) follows from de Broglie's theory as modified by the present theory. It is impossible for a particle to reach a high velocity unless it was first accelerated by means of a force acting upon it. A force acts through unit photon transference which results in the kinetic energy, an "invisible cargo" of photons, which accompanies the moving particle. This theory further states that the said mass increments are quantized according to certain critical quantum numbers. Therefore, when a certain photon density in the accompanying de Broglie waves has been attained, the said waves will exhibit definite inertial and ponderable properties, i.e. they will become matter or a field.

c) Once the existence of space and time quanta is accepted, the limiting or maximum velocity which is possible in ether is automatically defined. The Michelson-Morley experiments need a further comment.

As was previously stated, in this theory the space and time quanta are absolute and unchangeable throughout the universe. This is the original Newton concept.

However, Michelson-Morley experiments have shown that there is no ether drift. This looks like a cont radiction, because there should be a drift when the earth is moving about 30 km/sec while ether remains stationary.

The contradiction can be explained in plain language and without a necessity of changing the time or space units, as was done in the theory of relativity.

We simply assume that earth has a field of its own which moves together with it through ether. This is the gravitational field which incidentally has a great resemblance to a shadow.

Hence, this moving field is something like an island universe moving through ether without a drag. However, the space and time quanta in this island universe are the same as in the stationary universe.

Light is an entirely local phenomenon and its velocity is determined by the ratio of space and time quanta providing however, that the rays are permitted to travel in straight lines, as in vacuum or thin air.

Hence, the Michelson experiment simply proves that light is moving in the earth's relative field instead of in an absolute field. Note than all other physical phenomena including the inertial effects, electric currents, chemical reactions, etc., behave in a similar manner. There is no reason to believe that light should behave differently from other forms of radiations or forces.

15. Kinetic Energy and the Relativistic Mass Increase

The nature of kinetic energy was a favorite topic among scientists since the time of Aristotle. It was believed that a flying arrow carried with it an "invisible cargo" which a similar arrow at rest did not possess.

According to this theory, the idea of an invisible cargo is substantially correct.

As was already pointed out, the forces and energies are transferred from one particle to another and from one body to another in the form of a swarm of unit photons. The transference takes place in collisions, accelerations or any other changes of momentum. De Broglie waves are such swarms and when the swarms or waves reach a certain critical density (probably 1.23×10^{20} photons per space quantum), the increase of mass and inertia become measurable. Otherwise, i.e., below the critical density, the de Broglie waves are only fields having no measurable inertia or ponderable mass.

Hence, in a relativistic mass increase the major particles which have been accelerated, remain in a state in which they were originally and their numbers do not change. It is only the mass of the de Broglie wave which changes.

16. On gravitation and inertia

The quantized and energized ether is the cause of gravitation and inertia.

Mach and Einstein assumed that both effects were caused by the metric space-time complex which was energized by masses allegedly evenly distributed in the universe.

This theory does not require any such explanation. The gravitational field is spread over the ether field as over a carpet. As it was previously stated, when the earth is moving in its orbit around the sun, the gravitational field moves together with it while ether remains stationary. Nevertheless, the Michelson-Morley experiments may be explained in a simple manner by merely assuming that light being a local phenomenon independent of its source follows the moving field and not the stationary one. In this manner, the velocity of light remains constant in all directions and behaves in exactly the same manner as if the earth were not moving at all.

Inasmuch as the gravitational field exerts an attraction upon matter, it follows that the field is negative, i.e., it consists of a weakening of the ether field in the vicinity of masses. From this we conclude that gravitation is substantially a shadow effect. Inertial effects are entirely local, i.e., they do not comprise a field as does the gravitation and therefore are not related to gravitation.

As was stated, the structures of matter and ether are complementary of each other and comprise two congruent spatial divisions or networks.

For this reason there is no inertial effect observable during an absolute motion, i.e., a uniform motion in a straight line.

However, when forces act upon a body, the disposition of the accompanying de Broglie waves changes: they may increase in content and also may become non-symmetrical with respect to the moving body. This results in a change of momentum or direction and this change in turn reacts upon the structure of ether.

It may be assumed that ether resists a change of momentum and therefore forms a basis for a reaction to forces. It is readily seen that Newton's law of action and reaction is true not only among material bodies but it also includes ether.

Because, in following a chain of actions and reactions however long, ultimately we always must end in contact with space or ether.

Hence, inertia could not exist if ether did not exist at the same time, because all inertial changes and effects involve a transference of unit photons. On the other hand, it is impossible for unit photons to be transferred from one place to another without the use of space and time quanta, i.e., ether.

17. Causality and Determinism

This theory deals not only with problems in physics but also with philosophy.

Once we accept the idea that the entire universe, including ether, is in a state of quasi-perpetual tremor in which all particles and unit photons residing in space quanta are forever moving, vibrating or rotating, we must conclude that universe as a whole, resembles a living organism.

Of particular significance is to note that universe has gone through a long period of evolution before it has reached its present complex state. This is due to the law of entropy.

Accordingly, universe has evolved from a state of pristine orderliness, which is pure ether into a state of maximum or increased probabilities, which is chaos or varieties.

As was stated, ether is an entity which comprises a maximum of action and a minimum of unit photon content per space quantum. Entropy causes the said action to diminish and the specific photon content to increase. In this manner, matter was formed from ether.

In this article we have postulated that space and time are discontinuous and consist of indivisible units or quanta. This completes the picture of quantization, which condition of matter and events embraces the entire universe and makes it appear as consisting entirely of integers, spatial, temporal and energetic, containing no fractions.

This is important. Any entity containing no fractions cannot be divided into parts with a mathematical accuracy. After each division there is usually a remnant. From this it follows that the effect is never or very seldom exactly equal to the cause and usually equals it only approximately.

So, after each event, there is left a remnant of uncertainty. Through the course of time, these remnants are integrated and may become sizable and important. In other words, the future is not predictable with an absolute certainty from the past or present, nor is the past exactly determinable from the present.

It may be added that life itself would be impossible without the said uncertainties. Evolution is based therefore, on the existence of mutations and uncertainties and those again are based upon the quantized structure of nature.

18. On Fields

Fields are the connecting link between matter and ether. Ether cannot act against matter except through fields and matter cannot react upon ether except through fields.

From this it follows that fields cannot be formed in the absence of matter and ether. In fields, the action of ether is diminished and the specific photon content is increased.

In matter, the procedure is extended in that action is further diminished and the specific photon content is further increased.

This metamorphosis is due to the law of entropy.

Fields are of two kinds, the "closed" and "open" fields. Closed fields are self-sufficient and persist on the basis of standing waves as quasi-perpetual mechanisms.

For example, atoms are such mechanisms. Other fields are open such as the electromagnetic radiation and require a continuous energy or photon influx for their maintenance.

Gravitation is a unique field in that it is open and yet it requires no energy influx for its existence. From this we conclude that gravitation is a shadow field, caused by shadow of matter complexes falling upon ether. In this manner it causes a perturbance in the action of ether generally known as gravitation.

All fields are spread over ether and are, therefore, quantized both in spacing and the periods of vibration. Hence, we conclude that gravitation, being a shadow field, must have the same wave length as ether, 1.32×10^{-13} cm.

19. On Thermonuclear Energy

Atoms are geometrical configurations formed from ether. Some of these configurations are more probable than others.

As a rule, it might be said that due to the law of entropy, the tendency in nature is to form more probable combinations from the less probable ones.

The principles of Maupertuis and Fermat state that the courses of events always select the most probable paths, the paths of least action and least time

Correspondingly, the tendency is to form units containing the strongest possible bonds and the least amounts of energy. In this process of evolution, energy and action are liberated. This is the source of energies issuing from the processes of fission, fusion and radioactivity.

In fusion, that is, in the thermonuclear process, the object is to break up the less probable combinations and thus obtain energy by forming more probable combinations.

It is impossible to break up a "steady state" nucleus, having a certain degree of action except by means having a superior action. In other words, it is necessary to transform the structures of atoms to be worked on into a plasma, i.e., disassociated matter.

Strictly speaking, the term "thermonuclear" is a misnomer, because in dealing with photonic transmutations temperatures as such do not exist. Here we are dealing with actions only which are not to be associated with the macroscopic concept of temperature.

Temperature is an entirely extraneous and electronic or molecular phenomenon and has nothing to do with nuclei and nuclear fields.

Unfortunately, or fortunately, we are unable to use the vast amounts of energy residing in ether (about 68 kg calories per cm^3) because ether is a closed and untouchable field.

However, there might be some other electromagnetic radiations, such as certain gamma rays which possess sufficient action to penetrate the bonds of promising atoms and might be used to recombine them into structures possessing less energy.

The practical value of this theory resides mainly in the fact that it stresses the importance of action in lieu of temperature as heretofore, in the scheme of obtaining thermonuclear energy. Hence, an apparatus combining the fission and fusion processes in a single unit is indicated by this theory. An H bomb is an apparatus of this kind.

20. The specifications of ether

NAME	SYMBOL	VALUE	REMARKS
Velocity of light	c	3×10^{10} cm/sec	
Quantum of action	h	6.6×10^{-27} erg sec	Planck
Mass unit	m	1.66×10^{-24} gram	The solid core of a nucleon.
Frequency of ether	N	2.3×10^{23}/sec	Also the number of unit photons in m
Space quantum	d	1.32×10^{-13} cm	Also the diameter of core
Volume of m	Vol_m	1.2×10^{-39} cm^3	
Specific gravity	γ	1.38×10^{15} b/cm^3	Of the core and photons
Mass of unit photon	μ	7.2×10^{-48} gram	$= \frac{m}{n}$
Energy of m	E_m	1.5×10^{-3} erg	$E_m = mc^2$
Energy of μ	E_μ	6.48×10^{-27} erg	$E_\mu = c^2\mu$
Energy of m		3.57×10^{-14} kg cal	934 MEV
No. of quanta/cm^3		4.4×10^{38}/cm^3	Number of space cubicles/cm^3
Energy of μ		1.55×10^{-37} kg cal	
Energy of ether/cm^3		68 kg cal	
Volume of		5.2×10^{-63} cm^3	
Diameter of μ		2.7×10^{-27} cm	
Specific gravity of ether		3.16×10^{-9} g/cm^3	
Time quantum		4.4×10^{-24} sec	
Volume of matter in ether		2.3×10^{-24} cm^3/cm^3	Emptiness of ether
Mass of electron	m_e	9.1×10^{-28} gram	
Number of photons in electron		1.23×10^{20}	
Cross Section of μ		5.7×10^{-50} cm^2	5.7×10^{-26} barns

UNITED STATES PATENT #3,349,002 "NUCLEAR REACTOR"
By Nikola J. Trbojevich – Issued October 24, 1967 (Filed March 28, 1958)

To: Dr. James Corum and Dr. Jasmina Vujic 30 October 2000

From: William H. Terbo

Attached is a copy of my father's final U.S. Patent, FYI.

Father had a total of between 150 and 200 patents, U.S. and foreign. He was an independent inventor and consultant almost all of his life with a specialty in gears of all forms. His most famous invention was the mathematically conceived Hypoid gear in 1923. Used in the rear axle differential in rear drive automobiles, the gear allows the drive shaft from the engine to intersect the rear axle several inches below the axle centerline. Together with his invention of the even more complicated gear shaping (cutting) machinery (still in use today) to manufacture Hypoid gears, it changed the profile of all automobiles by 1931 (tall and boxy until 1930, six to eight inches lower after that). Among some of his other inventions were: all types of vehicle steering systems, constant velocity universal joints, positive displacement pumps, gauges and finally, the nuclear reactor. He worked for corporations during the Second World War and ended his career as a college professor.

The most interesting aspect of the Reactor patent is the extraordinary time between filing and issuance. Considering that the reactor invention was germinating for at least a year or two before filing, such a patent was far ahead of its time. This was not lost on the Patent Office. Dad assumed that they couldn't believe that an independent inventor, outside the government driven system, could devise something that was the preserve of academics and engineers working in a "secret" environment. The patent search was likely complicated by security concerns, as many nuclear patent applications were held up, or sequestered, to prevent disclosure to unfriendly or competitive foreign parties.

Dad believed he was on the FBI "watch" because of his work on nuclear technology (and because of his very close family relationship to various people in the highest levels of the post war Yugoslav government). He applied for a new passport just to see if he could get one. He got it, but it didn't change his mind about the "watch."

Regards,

Bill WHT/njtkm2

United States Patent Office 3,349,002
Patented Oct. 24, 1967

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3,349,002

NUCLEAR REACTOR

Nikola J. Trbojevich, 8106 E. Jefferson Ave., Detroit, Mich. 48214

Filed Mar. 28, 1958, Ser. No. 724,713
4 Claims. (Cl. 176—21)

The invention relates to an improvement in nuclear reactors which may be used in the propulsion of aircraft, rockets and vehicles, for breeding and the like.

The novelty resides in the construction of a rotary and fast reactor in which the energy is produced in a series of discontinuous pulses, instead of continuously as in prior designs. In order to accomplish this, the new reactor comprises a rotor and a stator in which the fuel elements are distributed in a plurality of discrete lumps or pads along the adjoining circumferences of the said rotor and stator.

The arrangement is such that whenever, as a result of rotation, two such lumps arrive in a juxtaposite position, a momentary chain process is established resulting in what might be called an intense nuclear spark. The said spark is promptly extinguished afterwards and the said fuel lumps are cooled and scavenged by means of a copious supply of compressed air or gas.

The object is to produce a momentary neutron and power pulse of the greatest possible intensity and that, without a damage to the fuel elements and the adjoining mechanism.

Another object is to construct a nuclear turbojet upon this principle.

Another object is to construct a combination in which a turbojet may be actuated either by a nuclear or a conventional fuel, together or separately.

Another object is to construct a turbojet or rocket which does not require oxygen or ordinary fuel for its operation.

A further object is to devise a compact mechanism comprising a compressor, a reactor and a turbine in which all three elements are mounted in the same tube and are rotatable by means of a single shaft.

Another object is to provide for the regulation or discontinuation of the nuclear fission by means of the withdrawal of the elements in the stator.

In the broad sense, the object is to construct a rotary reactor in which the momentary output is a function of the angular displacement of the rotor with respect to the stator and the duration of each pulse is dependent upon the angular velocity of the rotor. By this means the output is controlled in a relatively simple manner.

In the drawings:

FIGURE 1 is a geometrical diagram explanatory of the theory of the new reactor.

FIGURE 2 is a portion of the stator showing the means for adjustment and the disposition of the fertile material needed for breeding.

FIGURE 3 is a longitudinal cross section of the new nuclear turbojet operable by a combination of nuclear and conventional fuels.

FIGURE 4 is the section taken in the plane 4—4 of FIGURE 3.

FIGURE 5 is an indicator diagram of the Brayton cycles used in the turbojet.

FIGURE 6 is a schematic representation of a closed cycle modification.

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FIGURE 7 is another modification diagrammatically representing the cycle used for the propulsion of rockets and missiles.

The theory will be first explained.

In FIGURE 1 two highly enriched fissionable masses **11** and **12** are shown and indicated by cross-hatching.

The first said mass **11** is attached to a high-speed rotor and moves *tangentially* with respect to a similar mass **12** affixed to the stator.

In the coordinate diagram the abscissa is taken as the time t while the ordinate is the neutron flux f.

The said two masses, which are taken to be two similar parallelepipeds for simplicity are so selected that each parallelepiped is subcritical per se, but when they unite in a single parallelepiped **12** and **11'**, the latter position being indicated by the dotted lines in the axis **15** of the diagram, they become critical and generate a divergent chain process. The criticality is obtained by reducing the circumference of the combined cross section of the parallelepipeds from $4a+4b$ to $4a+2b$, as indicated in the diagram. The difference of $2b$ in the combined cross sections is selected to be just sufficient to raise the flux in the axis **15** to a predetermined value of f max. In the flux curve **14** the residual or minimum flux is indicated by the symbol f min.

It is to be noted that this process is somewhat similar to the well known process which is or was used for setting off atom bombs, except that the divergent chain process is now extinguished practically as soon as it is started, i.e., usually within 10^{-6} sec.

The arrows **13** indicate the escaping neutrons from the cross section ab of the parallelepipeds.

In FIGURE 2 a portion of the stator is diagrammatically shown. The fissionable mass **12**, also marked with PU (meaning plutonium) is longitudinally translated along the axis **15** by means of a rack **16**, plate **21** and pinion **17**. The object is to increase the width of the gap e for the purpose of discontinuing the chain process when so required. The said mass **12** is guided in a thin walled holding member **18** which also supports a considerable mass **20** of fertile material marked U–238 (uranium) at its outer circumference for the purpose of breeding. In airplanes and rockets I usually omit the said fertile material in order to reduce the weight of the apparatus and relegate the operation of breeding the required concentrated nuclear fuel to suitable ground installations.

In FIGURES 3 and 4 a complete nuclear turbojet apparatus is partly diagrammatically shown. The novelty resides in the design of the reactor and the method of operation wheretore the remaining elements, being well known, will only be briefly described.

As is seen in FIGURE 3, the apparatus is built along two mutually perpendicular and intersecting axes, viz, the horizontal axis **22** which is also the axis of the outer tube **23**, the drive shaft **24**, two bearings **26** and the turbine wheel **25**, the latter being integrally formed with the said shaft **24** and the perpendicular axis **15** which serves as the main axis of the reactor and as such is coaxial with the elevating rack **16**, the plate **21**, the bond **30**, the fuel pad **12**, the hollow rectangular insert and holder **18** and its integrally formed extensions **19**. The said holder **18** is affixed to the outer tube **23** in a suitable rectangular aperture formed in the wall of the latter by riveting or welding the said two elements together.

The ambient air enters the device at the left end of

FIGURE 3, as shown by the arrow **31**, and is first slowed down, then compressed, then heated, expanded in the turbine and finally, accelerated through the exhaust, i.e., the operation exactly corresponds to the well known Brayton cycle (see also FIGURE 4), which is used in ordinary turbojets.

The compressor comprises a rotor keyed to the shaft **24**, the said rotor consisting of a plurality of bladed disks **27** and intervening spacers **28**. The stator is affixed to the outer tube **23** and comprises a plurality of bladed rings, each having a plurality of blades **29** adapted to occupy the spacings provided by the said spacer disks **28**. Only one blade **29** is shown in the drawing, for clarity. It is further to be noted that the stator rings are split each in two halves in order that they may be assembled over the rotor.

The design of the new reactor having a vertical axis **15** will be readily understood from FIGURE 4. The rotor **32** is mounted upon the shaft **24**, is secured in position by means of the key **33** and rotates in the direction of the arrow **34** in unison with the rotor of the compressor **27** and turbine **25**. The said rotor usually has the form of a flat and exactly balanced slab capable of housing two similar fissionable masses **11** at its two ends where it is bounded by the cylinder **34A**. The adjustment of the outer fissionable mass **12** by means of a rack **16** and pinion **17** was already explained in connection with FIGURE 2 while the flux curve **14** generated by the reactor was similarly shown in connection with FIGURE 1.

Adjacent to the reactor are two oil burner tubes **35**. These may be of an entirely conventional design and need not be explained here in detail. However their purpose and role in the makeup of this invention is significant. I conceived the idea of a light and powerful source of nuclear energy for the propulsion of aircraft which could be constructed providing that the fission products could be blown out into the ambient air in their nascent state, as already mentioned in the preamble. Hence, the exhaust gases are radioactive and ionized. Therefore, the reactor cannot be very well operated until the plane has ascended to a safe distance away from the airfield. For this reason, this turbojet is designed to operate both on conventional and nuclear fuels.

The turbine **25** is preceded by a stationary diffuser **36**. The end cone **37** is used for the purpose or gradually increasing the effective cross section of the tailpipe and thus provides an orderly expansion of the gases issuing from the said turbine.

The tube **38** in FIGURE 4 serves for the injection into the reactor of neutron-rich light isotopes such as deuterium (H^2) or tritium (H^3) for the purpose of boosting the power by increasing the number of fissions. In this method it is possible to do so because of the much higher peaks of the flux curve **14**, FIGURE 1, obtainable in this reactor than could be obtained in the conventional or steady-flow reactors.

In FIGURE 5 an indicator diagram characteristic of the operation of the jet engine above described is shown. The diagram is of the Brayton type as already stated and corresponds to the dual drive shown in FIGURE 3, i.e., the incoming air can be heated either by nuclei or by hydrocarbons or by both. Thus, in the pv diagram, the first cycle relating to the nuclear modification and marked NUCL starts from the point **0** having first an adiabatic compression **0–1**, the ram effect, and **1–2**, the rise in the compressor. The horizontal line **2–3** indicates heat induction into the reactor, the said heat quantity adding to the volume and velocity of the gases but not to their pressure. From the points **3** to **4**, the turbine adiabatically expands the gases just sufficiently to produce enough torque to operate the compressor and the reactor and no more. From the points **4** to **5**, the gas expands through the exhaust tube down to the ambient and thus provides the jet needed for the propulsion of the craft.

The hydrocarbon cycle marked H–C runs through the points **5 3 6 7 8** and is quite similar to the one just described. The area of the combination of the two diagrams **0 2 6 8** represents the maximum power which the apparatus is capable of furnishing.

In FIGURE 6 a schematic diagram shows, as a modification, the application of the new reactor in a closed cycle. The advantage of the closed cycle resides in the fact that there is no radioactive gas issuing from the turbine into the exhaust. For this reason, the modification is suitable for the purposes of breeding, for power production, for submarines, etc. The elements in the cycle, FIGURE 6, are all so clearly marked that they will be clearly understood and no further explanation will be necessary.

In FIGURE 7, a very simple arrangement is shown according to which rockets and missiles may be propelled by means of nuclear power through empty space.

It should be noted in this connection that rockets are driven on the principle of equipartition of momenta and inasmuch as the momentum is the product of mass and velocity, it follows that energy alone is insufficient to propel a rocket in an empty space. In FIGURE 7 the matter to be backwardly ejected from the rocket is carried in the tank marked "Liquid Gas." A too rapid expansion of this gas is prevented by means of a rotating turbine wheel which also furnished the required power to the rotor of the reactor while the latter furnishes the heat energy required for the acceleration of the gas and the power lost in the turbine.

What I claim as my invention is:

1. A reactor comprising a cylindrical core rotatable about an axis, an outer stationary member tangential of the said core and two fissionable and subcritical masses respectively affixed to the said core and member and so selected that when the first said mass tangentially bypasses the second said mass in its proximity, the combined masses become momentarily hypercritical and momentarily generate a divergent fission chain reaction and in which the mass in the outer member comprises a slide and means for bodily moving the said mass in the said slide in a direction perpendicular to the said axis, for the purpose of adjustment.

2. A reactor comprising a cylindrical core rotatable about an axis, a hollow cylindrical member enveloping the said core, a plurality of fissionable masses discretely distributed along the adjoining circumferences of the said core and member, and means for moving the masses in the said enveloping member in a direction perpendicular to the said axis.

3. In a reactor, a combination of a rotor with a stator in which the said two members comprise a plurality of discrete fissionable units, in which the units in the said stator are outwardly retracted to provide a clearance, in which the stator is provided with means for injecting into the rotor additional neutron-rich material of the class consisting of deuterium and tritium and in which the speed of rotation of the said rotor is predetermined to produce a series of neutron pulses of the required magnitude and frequency.

4. A reactor according to claim **3** in which the units are over fifty percent enriched and require no moderator for their proper functioning.

References Cited

UNITED STATES PATENTS

2,812,304	11/1957	Wheeler	204—193.2

FOREIGN PATENTS

1,137,047	1/1957	France.
1,007,442	5/1957	Germany.
614,386	12/1948	Great Britain.

(Other references on following page)

OTHER REFERENCES

Glastone, Principles of Nuclear Reactor Engineering, D. van Nostrand Co., Inc., New York (1955), pp. 29, 36 and 738.

Murray II, Nuclear Reactor Physics, 1957, p. 5, Prentice-Hall, Englewood Cliffs, N.J.

Murray I, Introduction to Nuclear Engineering, 1954, pp. 96–99 and 349–366, Prentice-Hall, New York, N.Y.

"Aircraft Nuclear Propulsion Program," U.S. Government Printing Office, July 23, 1959, p. 361.

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NUCLEAR REACTOR

Filed March 28, 1958

FIG.1.

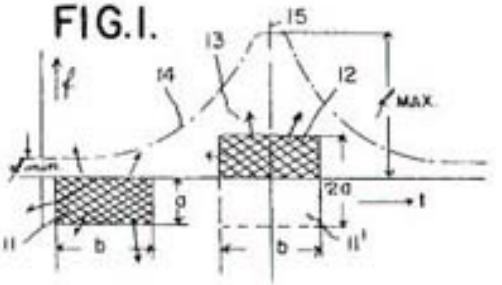


FIG.2.

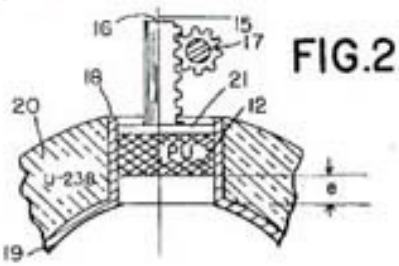


FIG.3.

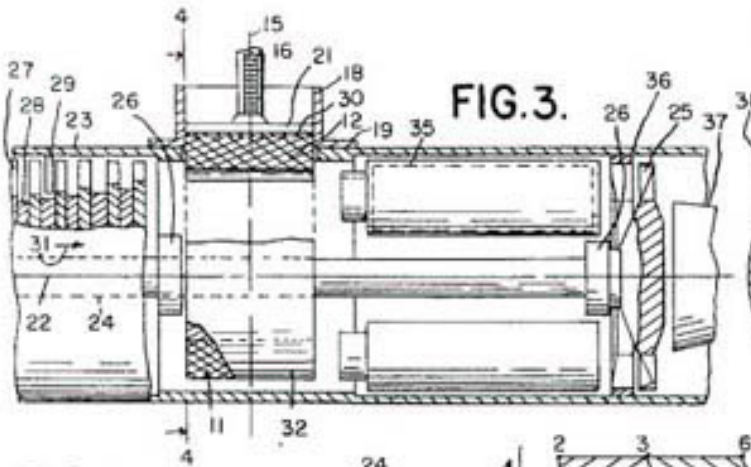


FIG.4.

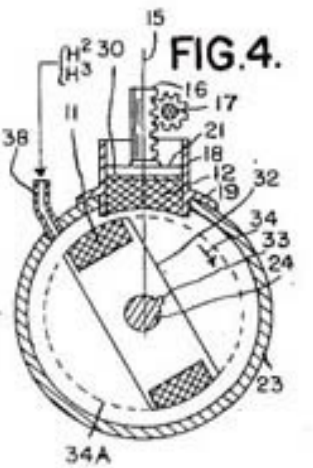


FIG.7.

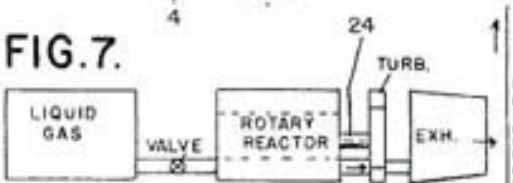
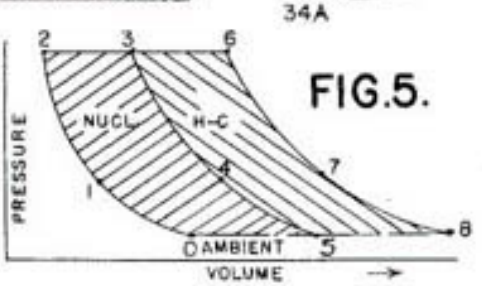


FIG.5.



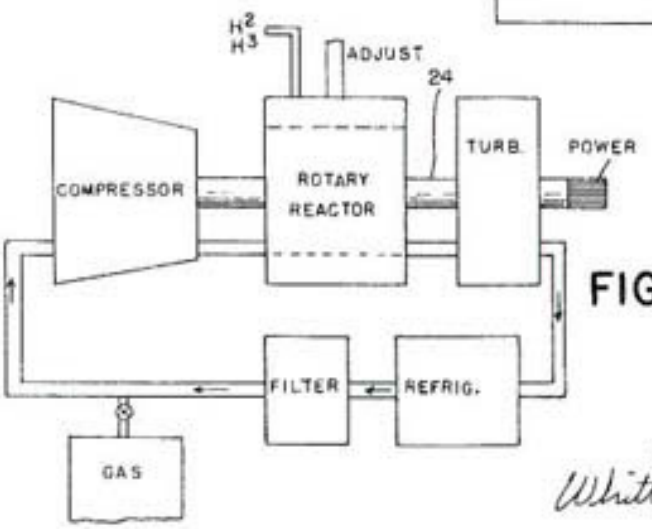


FIG.6.

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